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THE GEOMETRY OF AFRICAN ART
II. A CATALOG OF BENIN PATTERNS

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SUMMARIES

This paper investigates the repeated patterns found in the art of Benin, classifying them on the basis of the 24 plane crystallographic groups. Although the patterns are less varied than in Bakuba art, studied in an earlier paper [1971], the same number, 19, of types occurs. Drawings of each are given, including many examples of each of the seven "one-dimensional" types.

Diese Arbeit untersucht die wiederholten Muster, die in der Kunst von Benin vorkommen, und klassifiziert sie gemäss der 24 ebenen Kristallgruppen. Obgleich die Muster weniger vielfältig sind als in der Bakuba Kunst, die in einer früheren Arbeit untersucht wurde [1971], findet man die gleiche Anzahl von Typen wieder, namlich 19. Alle Typen sind durch Zeichnungen illustriert, die mehrere Beispiele von jedem der sieben "ein-dimensionalen" Typen enthalten.

1. *Introduction*

This paper continues the study of the geometry of African art begun in [Crowe 1971]. As in that paper, the technique is to use the known mathematical fact that there are exactly 7 strip and 17 two-dimensional plane patterns (admitting at least one translation) to classify the patterns appearing in Benin art. Since the 24 patterns are described briefly in my 1971 paper, and in more detail in [Speiser 1956, 81-95] and in [Shepard 1948], I do not repeat that description here.

Section 2 gives some background material on Benin. Section 3 discusses the patterns, with a comparison to their occurrence in Bakuba art (Table I). Section 4 discusses the question "geometry or nature" in relation to the representation of feathers and animal markings. Section 5 gives drawings of most of the strip designs I know of in Benin art, and a single example of each of the 12 two-dimensional patterns which are found.

The author is grateful to the British Museum for the opportunity to work there in the initial stages of this project, to Phillip Lewis of the Field Museum for his helpfulness during a visit there, to P.J.C. Dark for permission to spend several days with his encyclopedic collection of photographs of Benin art,

Figure 1: Typical Benin bronze plaque (British Museum photograph)

and to Claudia Zaslavsky whose encouragement led to the collection of this material and the inclusion of some of it in her *Africa Counts* [Zaslavsky 1973].

2. *Benin History*

In 1897, Benin City in Nigeria had for some time been almost forbidden to Europeans. In that year a small British expedition set out for it from the Coast, in spite of warnings that certain Benin ceremonies made this an inauspicious time, and was massacred en route. A retaliatory expedition was immediately sent from Cape Town, and a 700-man army captured and ransacked Benin less than 6 weeks later. The corpus of Benin art as it is known today is essentially the loot from this expedition. Von Luschan's [1919] definitive catalog of Benin art lists some 2400 pieces, most of which were brought back by this expedition.

The art world was astonished at the magnificent bronze castings which predominated in this material. Here was art which seemed to have no connection in style or in technical quality with the "primitive" art that later inspired artists like Modigliani and Derain. Von Luschan [1919, 15] suggested that "Cellini himself could not have made better casts, nor anyone else before or since to the present day." Indeed it was at first assumed that this Benin art must have a Portuguese origin, since it was known that the Portuguese had visited Benin already in 1485 and had sent missionaries as well as soldiers for the army of the king (*oba*). Moreover, Portuguese merchants, soldiers and weapons are represented on many of the castings.

Local Benin tradition, on the other hand, said that the art of bronze casting had been learned from Ife, a Yoruba city some 100 miles to the northwest, about 1280. But in 1897 Europeans did not yet know that there had been bronze casting in Ife. It was not until 1910 that the beautiful Ife bronzes were discovered by Europeans, and by that time it had already been realized that the Benin bronzes could hardly have a European origin. Even had Cellini or his equal been capable of this work it is not likely that he would have been on an expedition to Africa in 1500!

From what is now known, it can be assumed that the Benin art of bronze casting was in fact learned from Ife, but that the bronze plaques were a specialty invented in Benin, possibly inspired by some European model such as book illustrations. These plaques, which were made mainly in the hundred years or so after about 1550, were described by a traveler (Dapper) in 1668 as covering the pillars of the royal palace. However, in 1701 another traveler (Nyendael) made no mention of them. In fact, Nyendael had found the city laid waste and depopulated by civil war. It appears that the plaques (of which some 1000 survive) were taken down and stored in an outbuilding. An old chief who had been a palace attendant before 1897 reported that they were referred to on ceremonial occasions as a sort of card index of

information on appropriate ritual [Willett 1971, 105]. Figure 1 shows one of these plaques.

3. *The Patterns*

Although the number of different types of patterns is essentially the same in Benin art as in Bakuba art, the variety within the types, and the imagination with which the designs are carried out in Benin is much less. In spite of the fact that Bakuba art is more strongly influenced by a single basic artistic technique (weaving), it shows an enormous imagination in elaborating the possible designs within this framework. In Benin, on the other hand, one's impression is that the designs which appear are copied from nature, an extensive part of this "nature" being manufactured cloths, which themselves have relatively little variety. Other natural designs, such as bead arrangements, croco cile hide and fish scales are copies with little variation. Slightly more variety is shown in the representation of leopard spots and bird feathers, possibly because the originals are themselves less regular.

All of the possible 7 strip patterns occur in both Benin and Bakuba art. Table 1 gives comparative occurrences of the 17 two-dimensional patterns, using the standard crystallographic designations. (The most lucid mathematical account of these is in [Speiser 1956]. Speiser's notation is not standard, but the various notations are compared in [Coxeter and Moser, Table 3, 136].) The four types p4, p3, p31m, and p6 do not occur in either art. The two types pm and pmm, which would seem to be very natural, essentially do not occur in Bakuba art but are comparatively common in Benin. On the other hand, the designs p1, pg, p2, pgg, and p3m1, which are frequent in Bakuba art, are rare or non-existent in Benin. Thus, I have not found pg at all; p2 occurs only on a wooden mask of a cult transmitted by the Yoruba [Fagg 1970, 29; Willett 1971, fig. 90]; pgg occurs only on a chain mail design, which seems likely to be a direct copy of a European model. Except for the tessellations by regular hexagons representing hair on an ivory mask [Dark 1960, pl. 56] and one bronze mask [Dark 1962, pl. VI], some uncommon arrangements of equilateral triangles (as on the leg of the right hand boy in Figure 1), and possibly some leopard spots, the five patterns admitting rotations of 120° are missing in Benin art.

It also seems that patterns involving glide reflections are less common in Benin than in Bakuba art, probably because glide reflection symmetries tend to originate in weaving patterns. This impression is born out by the occurrence of all four of the groups involving "g" in their symbol in Bakuba art and only two (except for the single, apparently foreign, occurrence of pgg in chain mail) in Benin.

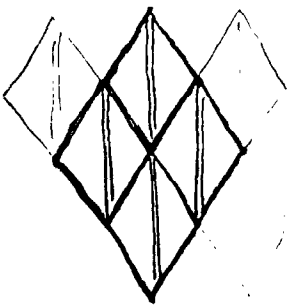
TABLE I

COMPARATIVE OCCURRENCE OF THE 17 TWO-DIMENSIONAL PATTERNS IN BAKUBA AND BENIN ART

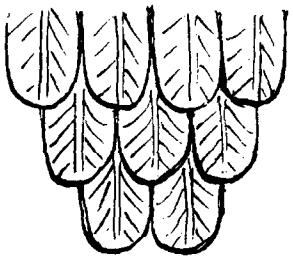
Type	Bakuba	Benin
p1	+	rare
pm	-	+
pg	+	-
cm	+	+
p2	+	rare
pmm	rare	+
pgg	+	rare (only as chain mail)
pmg	+	+
cmm	+	+
p4	-	-
p4m	+	+
p4g	+	+
p3	-	-
p31m	-	-
p3m1	+	rare
p6	-	-
p6m	+	rare

4. *Geometry versus Nature*

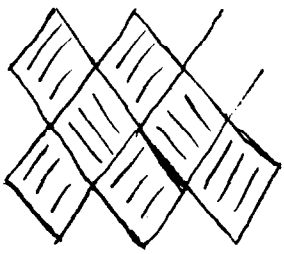
Since Benin art is representational, in contrast to the almost pure design of Bakuba art, its geometric content is not apparent at first glance. Even when some pattern appears in bronze it is often a copy of the work of some other artist, as in the representations of chain mail or cloth patterns, or of nature, as in crocodile or leopard skins. Even in such cases, however, the artist in bronze has some geometric choices, and insofar as he makes them he acts as a rudimentary geometer. Thus he may represent the coral beads of a necklace in a regular pattern cmm (like brickwork), while we may imagine that the actual



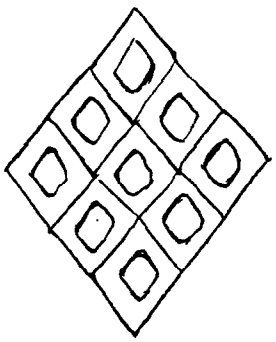
(a) cmm [Dark 1973, fig. 24]



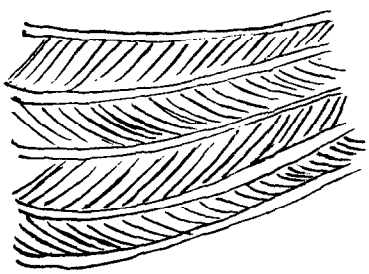
(b) cm [Dark 1962, pl. X]



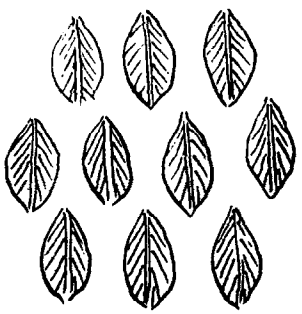
(c) p4g (pgg?) [Dark 1973, fig. 123]



(d) p4m [Dark 1973, fig. 123]



(e) pm [Dark 1973, fig. 24]



(f) cm [Luschan 1919, pl. 76]

Figure 2: Representation of feathers in Benin art

beads of this is a "copy" are not nearly so regularly arranged.

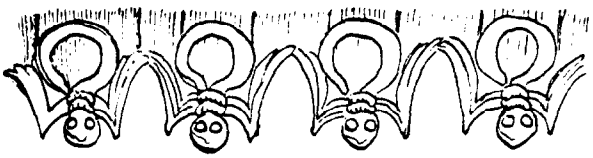
When representing objects which in nature already display *regular* patterns (as in the crocodile illustrating pmm) the resulting geometry is nature's, not the artist's. But when representing less regular natural patterns, such as bird feathers or leopard spots, the Benin artist made a variety of choices, some of which can reasonably be called *geometric*. Figure 2 shows a variety of representations of bird feathers. In some of these, such as (c) and (d), geometry has completely replaced nature. In others, such as [Dark 1960, pl. 85], the representation entirely lacks geometric content.

Arrangements of circles appear in a variety of places in Benin art: random ornament on cloth [Dark 1960, pl. 19]; background on certain plaques instead of the more common floral pattern [Dark 1973, fig. 103]; at the centers of squares or rhombuses in grids of parallel lines [Dark 1960, pl. 24]; as representation of hair on bronzes [Dark 1962, pl. VI; Roth 1903, fig. 259], and on an ivory mask [Dark 1960, pl. 56]; and as representation of leopard spots [Dark 1973, figs. 27, 80]. Of these, the first two seem completely random, while the third takes on the pattern of the grid of lines (pmm or p4m). The circles representing hair are sometimes in nearly hexagonal close-packing (p6m), especially on the ivory mask [Dark 1960, pl. 56] where the worn-down circles appear as regular hexagons, or [Roth 1903, fig. 259] in a checkerboard arrangement (p4m). The leopard spots vary, just as the bird feathers vary. In the famous ivory pair belonging to the Queen of England [Dark 1973, fig. 80] the arrangement is clearly p4m, while on the leopard of [Roth 1903, fig. 258] the arrangement is basically p6m. On other leopards, such as [Fagg 1970, pl. 2], the spots are less regular. In all cases in Benin, however, leopard spots are always represented by circles. It is interesting to compare this with the representation of spots by four-sided figures (approximately p4m) in the recently excavated 2nd-century B.C. Chinese leopards [Madden 1974, 853].

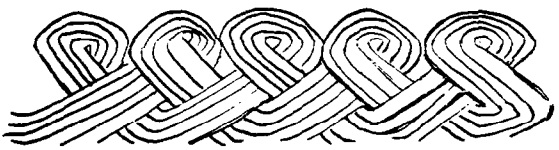
5. *A Catalog of Benin Patterns*

The following pages illustrate most of the strip designs I have found in Benin art, classified under the seven mathematically possible types. In the captions are given type numbers, typical examples, generating isometries, types of artifacts, and source. In most cases where no reference is given, the object is in the British Museum collection. Following this fairly complete catalog of the strip designs appears one example of each of the 12 (out of 17 mathematically possible) two-dimensional patterns which actually occur. For the drawings I am indebted to C. Brainerd and E.R. Keeney, each of whom helped me over hurdles I would otherwise not have cleared. The drawings have deliberately not smoothed out irregularities, but are intended to reflect both the spirit and detail of the original.

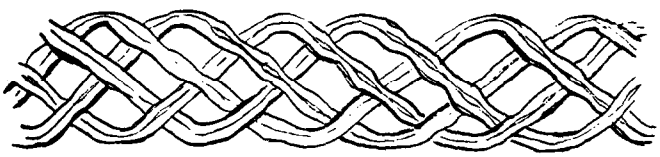
TYPE 1. *Typical example:* ... LLLL ...
Generating isometry: 1 translation



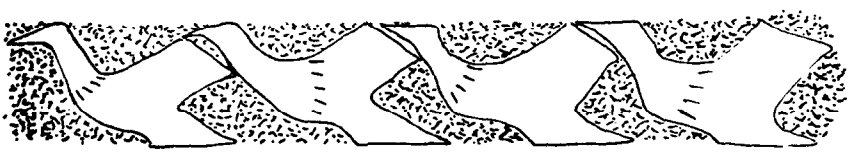
(a) bronze mask [Pitt-Rivers 1900, fig. 87]
The mudfish are asymmetric.



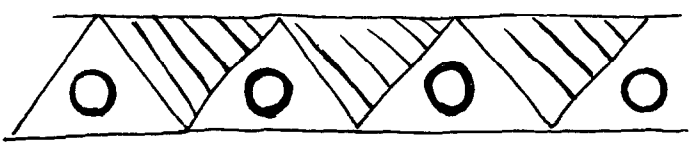
(b) looking-glass door-frame [Roth 1903, fig. 245]



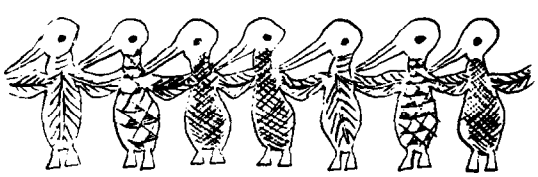
(c) bronze horseman [Dark 1960, pl. 57]



(d) kola-nut box [Dark 1962, pl. XXIII]



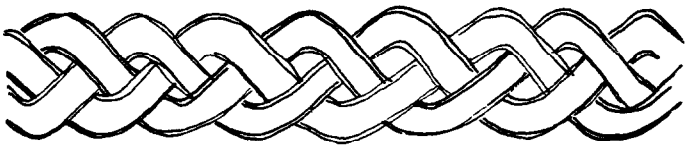
(e) bronze mask [Dark 1962, pl. XXII]



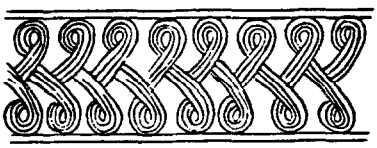
(f) ivory armlet [Luschan 1919, fig. 613]

TYPE 2. *Typical example:* ... LΓLΓ ...
Generating isometry: 1 glide reflection

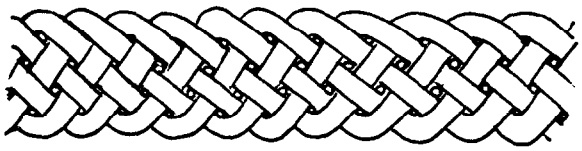
(a) carved box



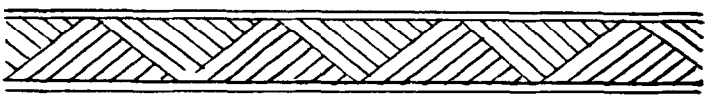
(b) bronze figure [Willett 1971, pl. 170]



(c) bronze armlet



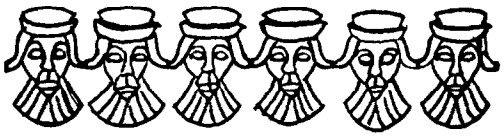
(d) ivory mask [Dark 1960, pl. 56]



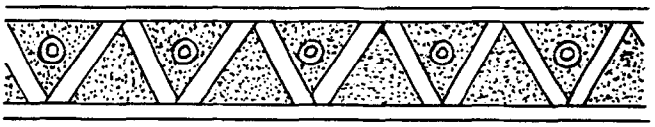
(e) brass lamp [Roth 1903, fig. 122]

(f) brass ornament [Pitt-Rivers 1900, fig. 306]

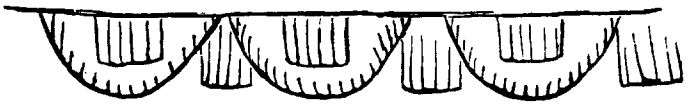
TYPE 3. *Typical example:* ... VVVV ...
Generating isometry: 2 reflections



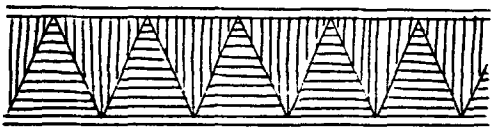
(a) ivory mask [Dark 1960, pl. 56]



(b) bronze plaque [Dark 1962, pl. XV]



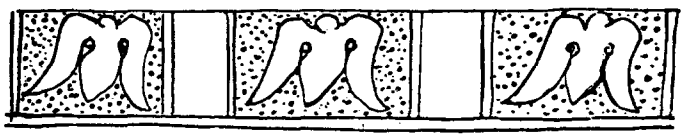
(c) bronze plaque [Dark 1960, pl. 17]



(d) bronze mask [Fagg 1970, pl. 21]

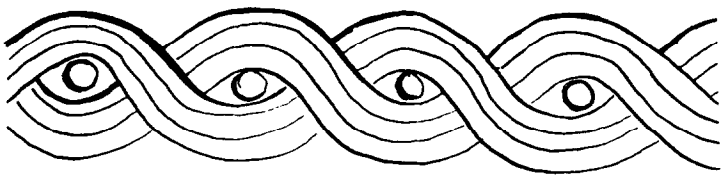
(e) bronze mask [Christensen 1955, fig. 24]

(f) brass leopard mask [Pitt-Rivers 1900, fig. 62]

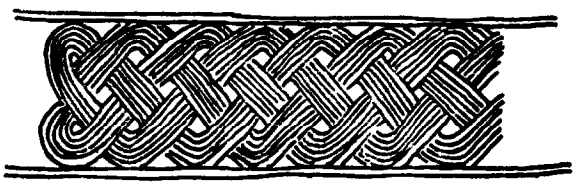


(g) bronze plaque

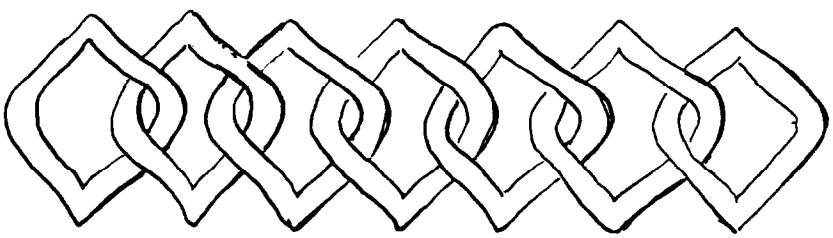
TYPE 4. *Typical example:* ... NNNN ... *Generating isometries: 2 half-turns*



(a) bronze plaque [Dark 1960, pl. 34]



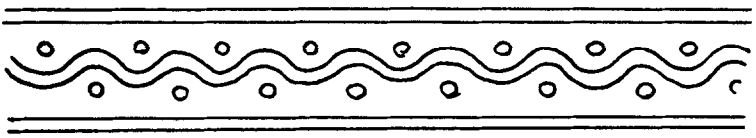
(b) carved tusk [Dark 1960, pl. 72]



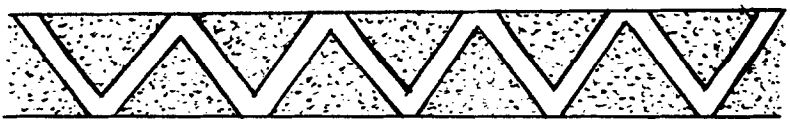
(c) bronze jar [Dark 1962, fig. 85]

(d) bronze head [Dark 1960, pl. 80]

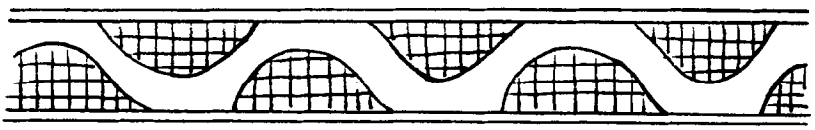
TYPE 5. *Typical example:* ... VAVA ...
Generating isometries: 1 reflection, 1 half-turn



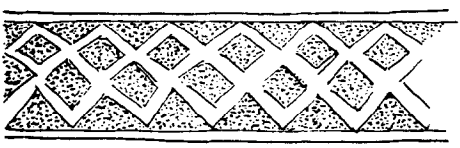
(a) bronze figure [Dark 1960, pl. 25]



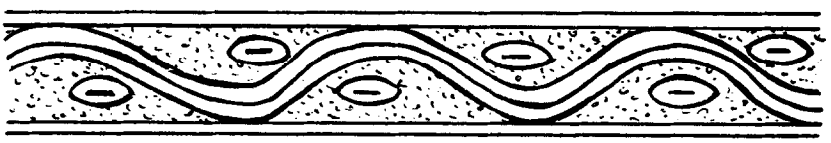
(b) bronze plaque [Dark 1960, pl. 26]



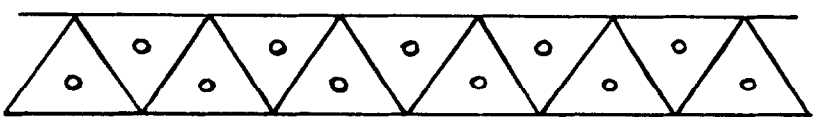
(c) wooden bird [Dark 1962, pl. XLII]



(d) bronze jar

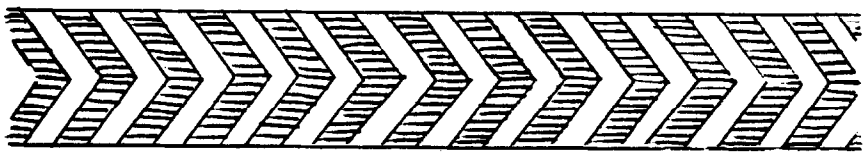


(e) brass lamp [Roth 1903, fig. 122]

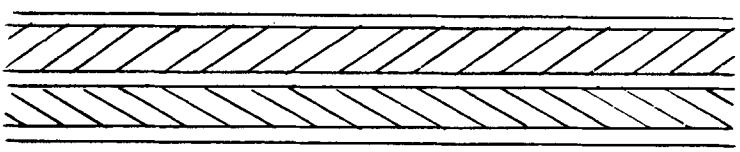


(f) bronze plaque [Dark 1962, pl. XVI]

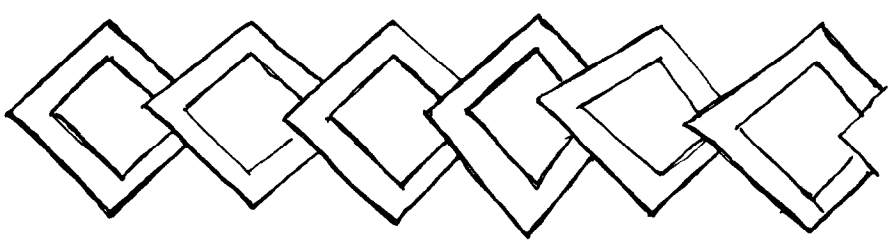
TYPE 6. *Typical example:* ... DDDD ...
Generating isometries: 1 translation, 1 reflection



(a) bronze figure [Dark 1960, pl. 24]



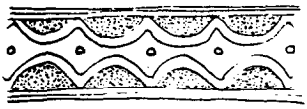
(b) brass lamp [Roth 1903, fig. 122]



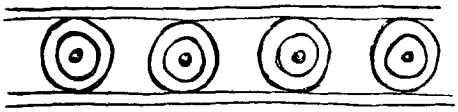
(c) brass-covered head

TYPE 7. *Typical example:* ... HHHH ...
Generating isometries: 3 reflections

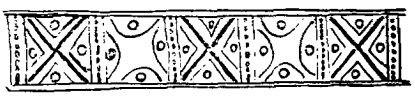
(a) bronze pedestal [Pitt-Rivers 1900, fig. 324]



(b) bronze plaque [Dark 1962, pl. III]

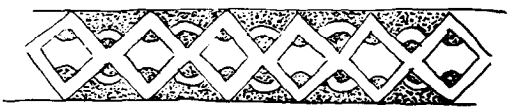


(c) bronze plaque [Dark 1960, pl. 26]



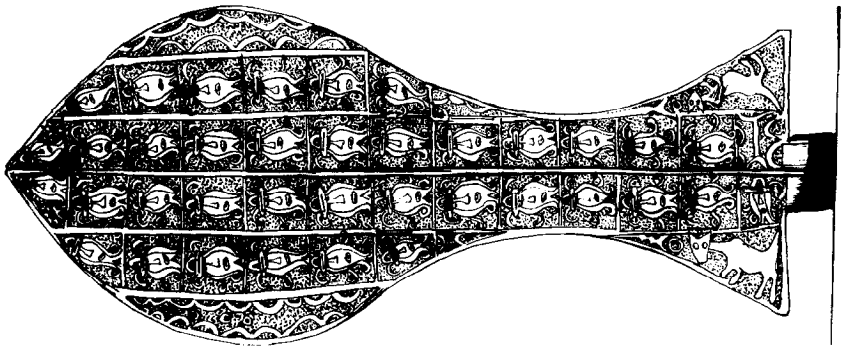
(d) bronze plaque

(e) bronze plaque [Dark 1960, pl. 30]

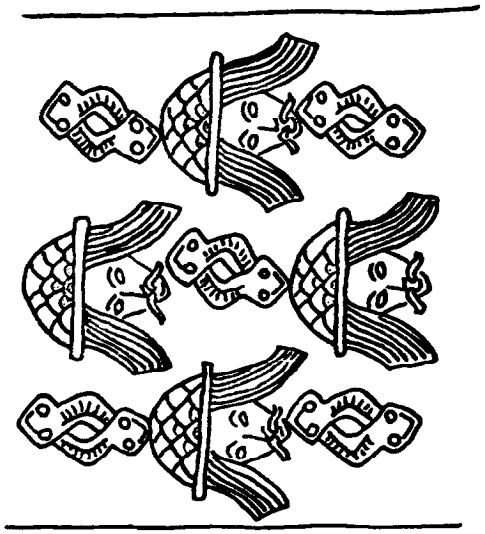


(f) bronze figure [Dark 1973, fig. 94]

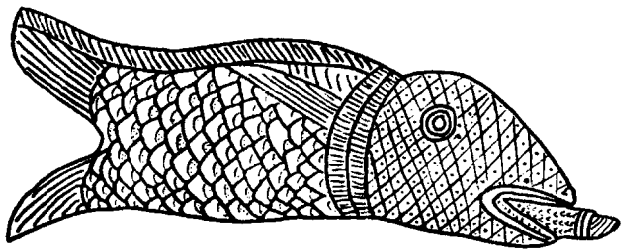
(g) bronze disc [Luschan 1919, pl. 104]



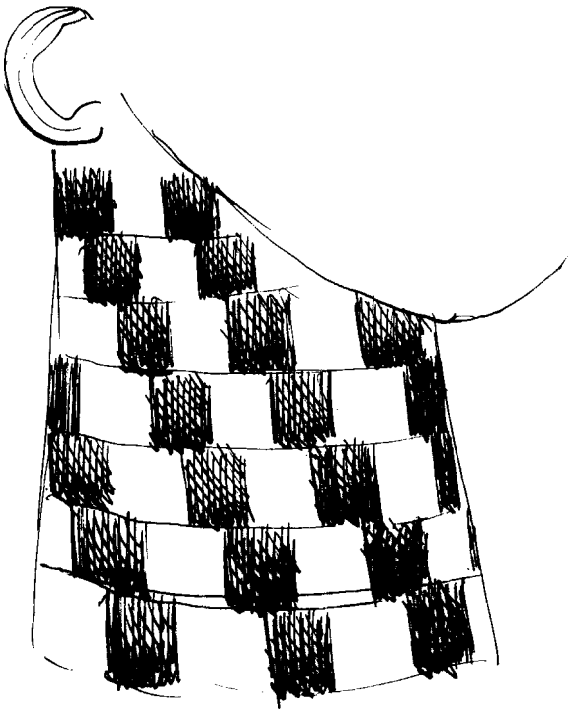
pm. ceremonial sword



pl. bronze armlet [Pitt-Rivers 1900, fig. 141]



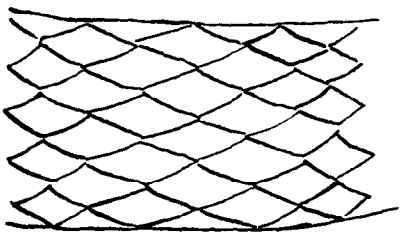
cm. bronze plaque [Dark 1962, pl. XXXIV]



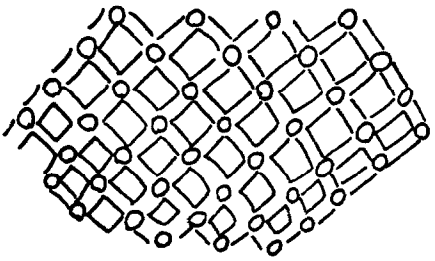
p2. wooden mask [Willett 1971, fig. 90]

pgg. bronze figure (chain mail)
pmg. bronze figure (headdress)

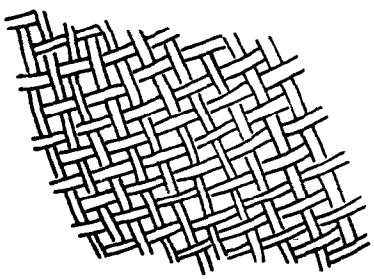
pmm. bronze plaque [Dark 1960, pl. 86]



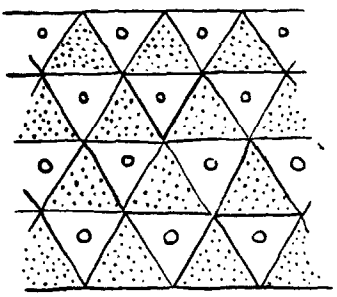
cmm. wooden head [Dark 1960, pl. 74]



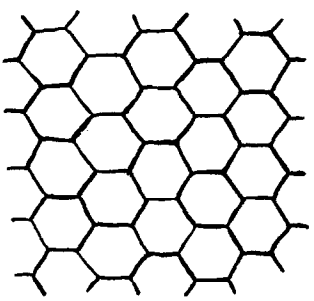
p4m. bronze head [Dark 1960, pl. 70]



p4g. bronze head [Luschan 1919, pl. 53]



p3ml. bronze plaque [fig. 1, this paper]



p6m. ivory mask [Dark 1960, pl. 56]

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CORRECTION!

The meeting of the "Two Hundred Years of Mathematics in America" Conference at Miami University, Oxford, Ohio will take place on October 3-4, 1975 and not on October 34 as announced in *HM* 2, 203.